AN EVALUATION OF THE STATUS OF THE COMMERCIAL FISHERY FOR CATFISH IN WISCONSIN BOUNDARY WATERS, MISSISSIPPI RIVER

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INTRODUCTION

Considerable fluctuations in the annual commercial catch of catfish from certain Mississippi River pools with important catfish fisheries aroused concern that over-fishing might be resulting in below optimum harvest. Over-fishing occurs when an excessive rate of fish removal (1) reduces the productive capacity of the population to a level where insufficient numbers of young fish can be produced to provide the maximum sustained harvest; or (2) decreases the age and size of the fish available for harvest below that point where the maximum rate of net weight gain (growth minus mortality per unit time) is realized; or (3) a combination of both conditions.

In general the commercial catfish fishery is more intensive in Iowa-Wisconsin and Iowa-Illinois boundary waters of the Mississippi River than upstream in Wisconsin-Minnesota waters.

METHODS

Two major areas of investigation were involved in this study: (1) the statistical history of the commercial catfish fishery, and (2) the size and age structure of the catch.

Annual statistics on commercial fishing effort and catch in Wisconsin boundary waters have been recorded since 1953. The reporting system was improved in 1960, but the earlier data still provides useful information on fishery trends. The statistics examined included: (1) the amount of gear fished for those gear types taking a significant part of the catfish catch; (2) the catch of each gear type; and (3) the efficiency of each gear type (catch per unit effort). These statistics were analyzed separately on an annual basis for the Minnesota-Wisconsin and Iowa-Wisconsin sections of the Mississippi River, as the two areas are controlled by different commercial fishing regulations. In general, the Iowa-Wisconsin regulations are more liberal than those for Minnesota-Wisconsin (Table 1).

Three river pools with important catfish fisheries were selected as representative areas for more intensive study of the catfish harvest through samples of the catch taken at local fish markets. Data were collected from catch samples during four years, 1963-65 and 1967. Sampling procedures varied considerably between years with respect to the type of information collected (length and/or age data) and the extent of the sampling (the number of locations sampled, the months in which they were collected, and the size of the samples taken) (Table 2).

Table 1. Commercial Fish Regulations for Catfish in Wisconsin Boundary Waters of the Mississippi River.

Gear Type	Regulation
	Wisconsin - Minnesota Waters
Setlines	Size limit 15 inches. Open season May 1 through October 31. 4 lines with 100 hooks per line may be used.
Gill nets	Size limit 20 inches. Continuous season. Minimum mesh size 7-inch stretch measure.
Seines	Continuous open season. Size limit 20 inches except during the period August 1 to September 30, when size limit is 15 inches and 200 pounds per day.
	Wisconsin - Iowa Waters (13-inch size limit for all gear)
Setlines	Continuous open season. 8 lines with a maximum of 50 hooks per line may be used.
Gill nets	Continuous open season. Minimum mesh size 7-inch stretch measure.
Seines	Continuous open season. No gear or mesh restrictions.
Buffalo nets	Continuous open season. No gear or mesh restrictions.
Bait nets	Continuous open season. 4-foot hoop front required. No restrictions on mesh size.
Frame nets	Closed season May 15 to September 15, inclusive. 4 x 8-foot hoop front maximum dimensions, with only a single lead. No restrictions on mesh size.
Slat nets	Open season Saturday nearest May 1 to October 31. Net not to exceed 6 feet in length and 72 inches circumference, one end closed with mesh not less than 1-1/4-inch bar measure.
Trammel nets	Continuous open season. Maximum length 300 feet. No restrictions on mesh size. Net must be drifted.

Table 2. Numbers of Catfish Measured and Aged from Fish Market Samples

Time Period	Location					
	Pool 4a		Pool 7		Pool 9	
	Measured	Aged	Measured	Aged	Measured	Aged
1963						
May-June	32	31	87	85	180	180
July			70	68		
August						
September	19	17				
TOTAL	51	48	157	153	180	180
1964						
May-June	24	24	235	163	654	379
July	43	43	347	245	186	95
August	48	48	216	210	249	185
September			233	183	320	172
TOTAL	115	115	1,031	801	1,409	831
1965						
May-June			833		627	
July			140		331	
August			42		663	
September			452		330	
TOTAL			1,467		1,951	
1967						
May-June					2,623	
TOTAL					2,623	

RESULTS

STATISTICAL HISTORY OF THE COMMERCIAL CATFISH FISHERY

Minnesota-Wisconsin Boundary Waters (Pools 3-8)

Setlines have been the primary gear in the catfish fishery in the Minnesota-Wisconsin portion of the Mississippi River, generally producing over 90 percent of the catch. Gill nets and seines each averaged under 10 percent of the catch.

Most of the above-average effort with setlines occurred from 1959-64, with 1954 and 1967 also higher than the mean level (Figure 1). Highest levels occurred in 1954 and 1960-61. The least setlining was done in 1957 and 1965. In general, fluctuations in effort in recent years have been smaller than in the earlier period, with no apparent trend over the entire 18-year period.

The setline catch had three below-average periods (1953, 1956-58, and 1962-66) and three above-average periods (1954-55, 1959-61, and 1967-70). The general trend was upward, with a record high catch in 1970. The most recent low catches were considerably higher than in the preceding low catch period.

Setline efficiency was below average 1953-63, with the exception of one above-average year, 1955. From 1964-70 efficiency has been above-average, except for one below-average year in 1967. The general trend has been upward, with 1970 a record high.

Comparing the three fishery statistics, setline effort and catch generally followed a similar pattern from 1953-1967, after which catches continued to increase while effort dropped off. Above-average efficiency prior to 1968 was accompanied by below-average effort and variable catches. Lowest efficiency occurred with below-average catches and variable effort. High efficiency in 1968-70 coincided with high catches and moderately low effort.

Iowa-Wisconsin Boundary Waters (Pools 9-12)

Four types of fishing gear have been significant to the Iowa-Wisconsin catfish fishery. Slat nets have generally been the largest producer, followed by setlines, bait nets, and buffalo nets. Conversion to a common unit of effort is necessary for combining the different gear types, since their efficiency per unit of effort is considerably different. The ratio of the efficiency of setlines to that of the other respective gear types was used to convert the latter to setline effort equivalents. Effort conversions were made from ratios calculated for each year individually and also from one average ratio for the 18-year study period. Fluctuation trends are identical to

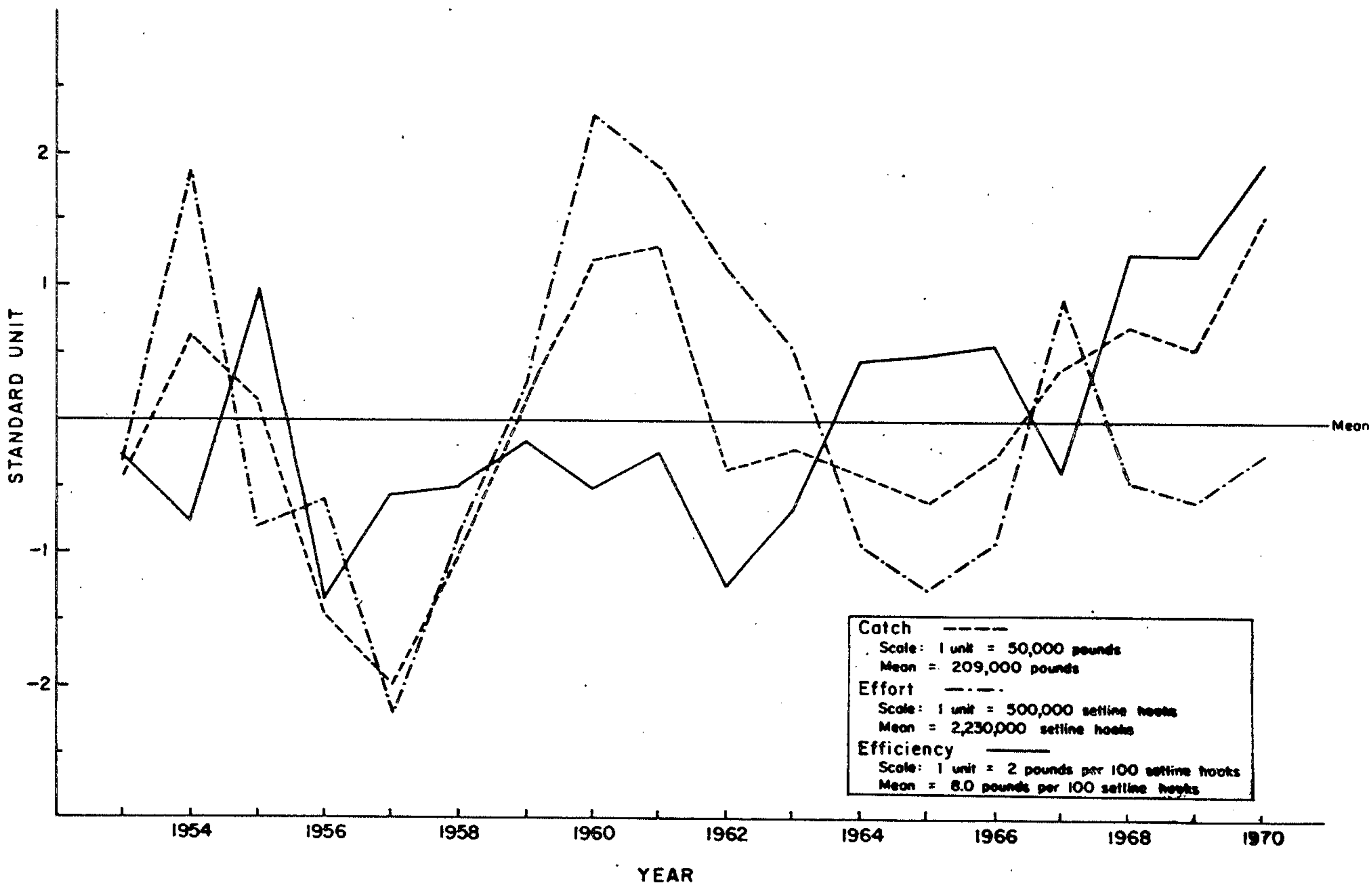

Figure 1 Setline Catch, Effort and Efficiency for Catfish in Minnesota-Wisconsin Boundary Waters.

those of the actual gear units for the latter method, while they generally are not when annual ratios are used.

Slat net effort was near the 18-year mean level in 1953, and dropped to its lowest level during the study during the remainder of the 1950's, (Figure 2). Effort increased to above-average levels in 1960 and remained there through 1968, with highest levels between 1964 and 1967. By 1969-70 effort had dropped to near average levels similar to 1953, so that no apparent net change occurred over the study period. The pattern changes considerably if annual efficiency ratios are used. For the first 12 years effort fluctuated frequently between slightly below average and high levels, except for low levels in 1955-56. Effort peaks appeared in 1954, 1958-60, and 1963-64. After 1964, effort declined steadily for six years to the lowest recorded levels in 1969-70, for a net trend of decline over the entire study period.

Setline effort was above average for almost all of the first half of the study period with peak levels in 1954 and 1959-60, and below average the remainder with lowest levels in 1964-66 and 1969. The net trend was definitely one of decline. Since setlines were selected as the basic unit of effort, there is no difference between 18-year mean and annual graphs.

Effort with bait nets was well below the mean for the first half of the study period, rose to levels near average to moderately above from 1962-67, and increased drastically to record high levels in 1968-70. A definite trend of increasing effort was evident. A similar pattern appeared using annual efficiency ratios, except that the most recent years did not show as exceptionally high levels. The last study year again was the record high.

Buffalo nets were fished at low levels early in the study. Effort was below average for the first half of the study period based on 18-year mean ratio and the first one-third annual ratios. The remainder of the period brought mainly above average effort with a general trend downward to near average levels in recent years. The net trend for the entire period was upward.

Total effort was obtained by combining the four major gear types. An increasing trend was evident for values based on 18-year mean efficiency ratios, with below-average effort prior to 1960, and above average after 1961 (Figure 3). Lowest effort occurred in 1957 and highest in 1968. When annual efficiency ratios are used, most of the above-average effort occurred in the middle of the study period, 1958-64. With the exception of 1954, the first five and last six study years were below average. No net change was apparent for the entire period. Total effort in Minnesota-Wisconsin waters averaged 60 percent of that for Iowa-Wisconsin waters.

Slat net catches have followed a cyclic pattern with highs in 1954, 1958-60, 1964-67, and lows in 1955-57, 1961-63, and 1968-70 (Figure 4). The trend has been toward increasing fluctuations, with the most recent increases and declines both larger than the preceding ones. The next few years will determine if catches will again rebound from the record low of 1969-70 as they did during the study period.

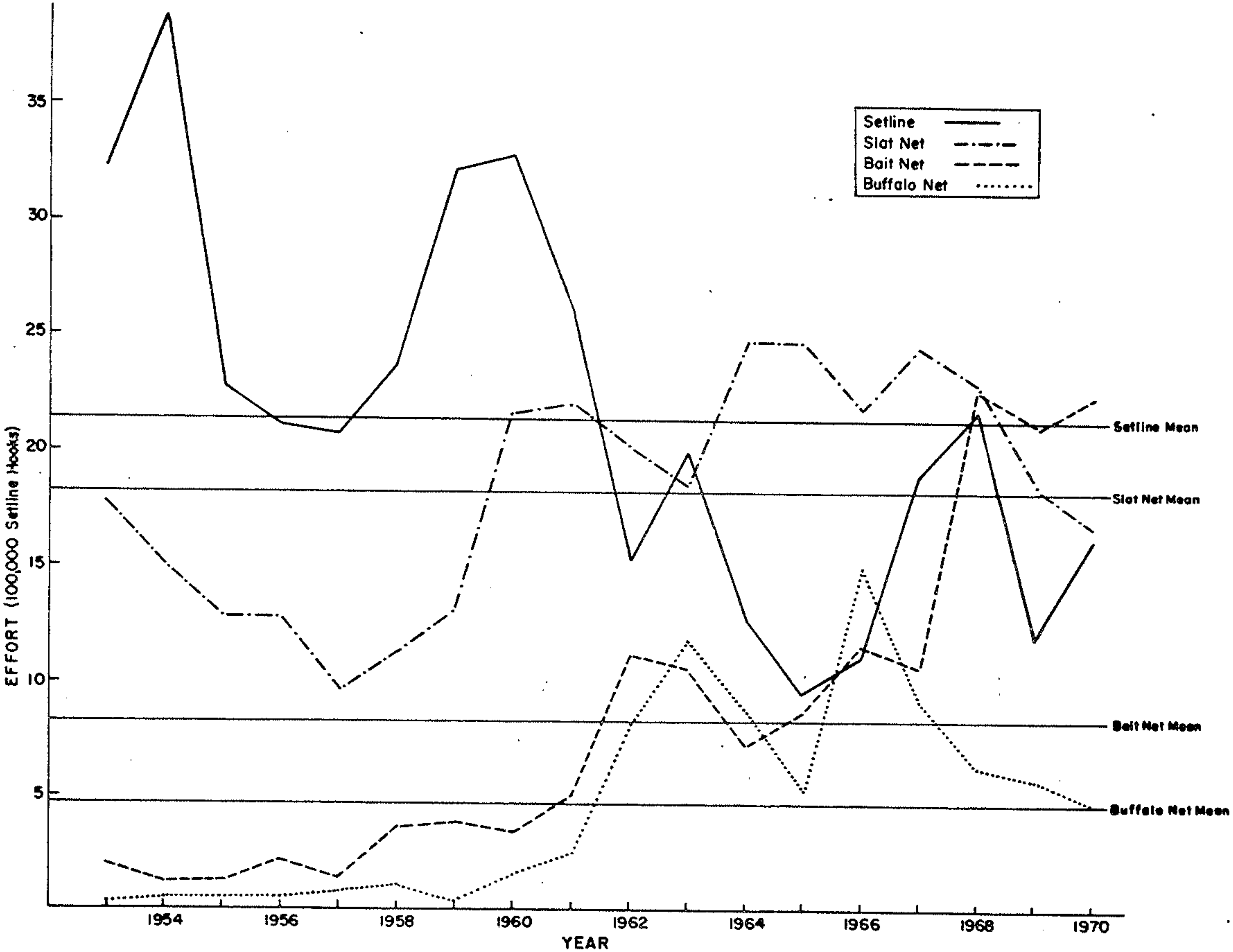

Figure 2 Fishing Effort for Catfish in Iowa-Wisconsin Boundary Waters with Major Gear Types. Conversion to Setline Hook Equivalents Based on the Ratio of 18-Year Mean Efficiency for Each Gear to that of Setlines.

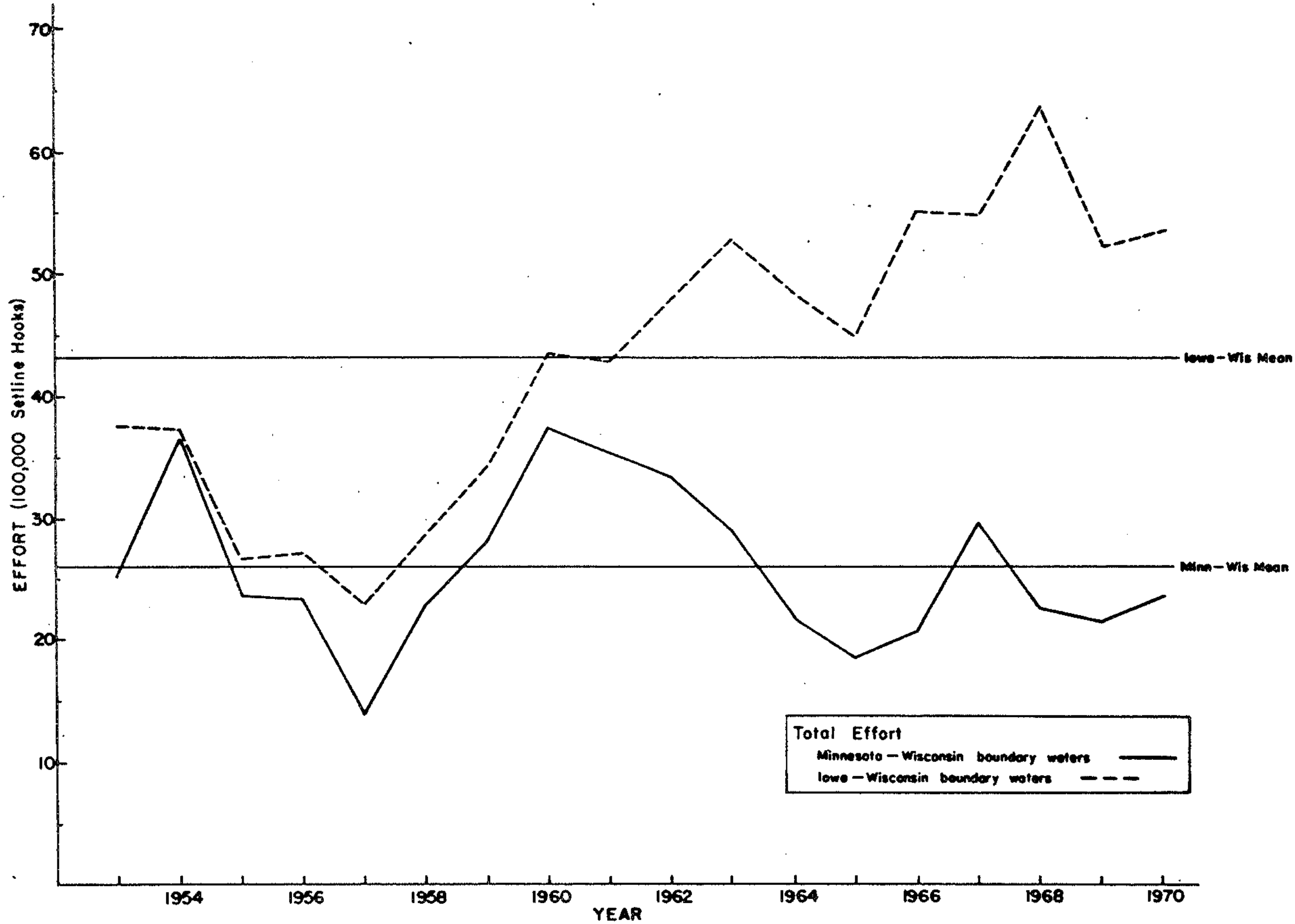

Figure 3 Fishing Effort for Catfish in Minnesota-Wisconsin and in Iowa-Wisconsin Boundary Waters, All Major Gear Types Conbined. Conversion to Setline Hook Equivalents Based on Ratio of 18-Year Mean Efficiency for Each Gear to that of Setlines.

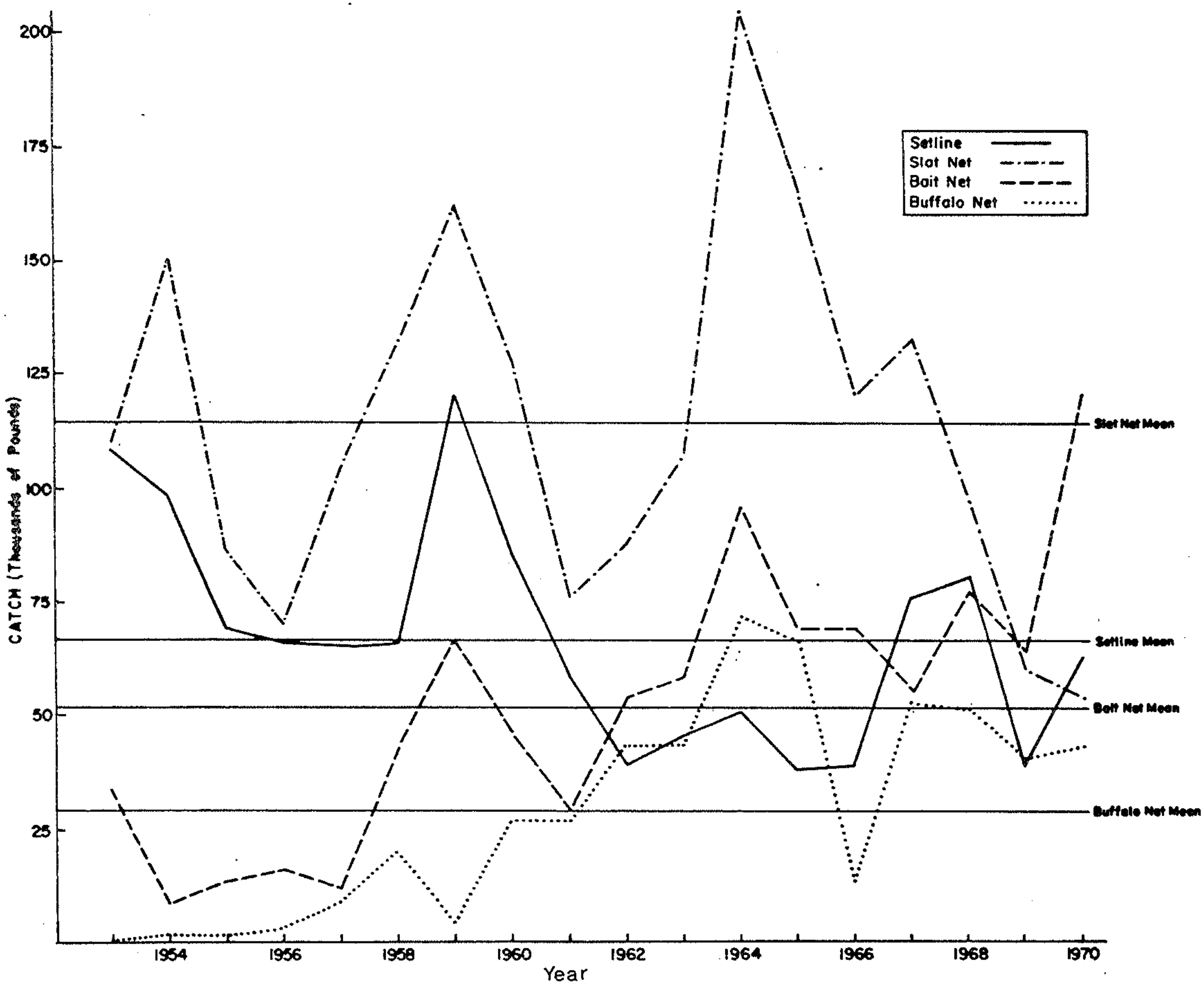

Figure 4 Catfish Catch in Iowa-Wisconsin Boundary Waters by Gear Type.

Setline catches were generally near or above-average from 1953-60 and below-average since then with the exception of 1967-68. The net trend has been downward. Best catches occurred in 1953-54 and 1959 and lowest in 1962, 1965-66, and 1969.

Bait net catches have shown a definite increasing trend, with 1953-61 below-average (with the exception of 1959) and 1962-70 above-average. Lowest catches occurred 1954-57 and highest in 1964 and 1970.

Buffalo net catches followed an increasing trend very similar to bait nets, with below-average catches through 1961 and above-average 1962-70, except for one low year, 1966. Lowest years were 1953-56 and highest years 1964-65.

The total Iowa-Wisconsin catch has been characterized by numerous fluctuations with no noticeable net change over the 18-year period (Figure 5). Highest catch years included 1959 and 1964-65 and lowest 1955-57, 1961, and 1969. Minnesota-Wisconsin catches averaged three-fourths of those in Iowa-Wisconsin waters. There were two years when the Minnesota-Wisconsin catch appreciably exceeded the Iowa-Wisconsin catch, 1955 and 1961. In the last two years catches in the two sections were about the same.

Efficiency levels of the four gear types were plotted relative to a common mean so that comparisons could be made despite the variation in effectiveness of a unit of gear of each type. The highest slat net efficiency occurred prior to 1960, with peak levels 1957-59 (Figure 6). Efficiency was below-average 1960-70 with the exception of two slightly above-average years in 1964-65. The overall trend was a declining one, with record lows in 1969-70.

Setline efficiency trends were generally the reverse of slat nets, with sub-average levels prior to 1964 except for two years, 1953 and 1959. Above-average efficiency has existed since 1964, with highest levels in 1964-65 and 1967. Lowest efficiency occurred in 1954 and 1960-63.

Bait net efficiency closely paralleled that of slat nets in 1961-70, remaining below-average for all years except 1964. The pattern preceding 1961 was also similar to that for slat nets, but delayed by one year. Highest efficiency levels were recorded in 1953 and 1959, lowest in 1968-69. The general trend was a declining one.

High buffalo net efficiency occurred in the same general period as high slat and bait efficiency, 1957-60. Three low points in buffalo net efficiency occurred in 1953-55, 1963, and 1966. Efficiency was stable and near the mean for 1968-70.

In summary, during the first three years, slat and bait net efficiency was generally above average and setline and buffalo net, below. By 1956 all gears were similarly slightly below-average.

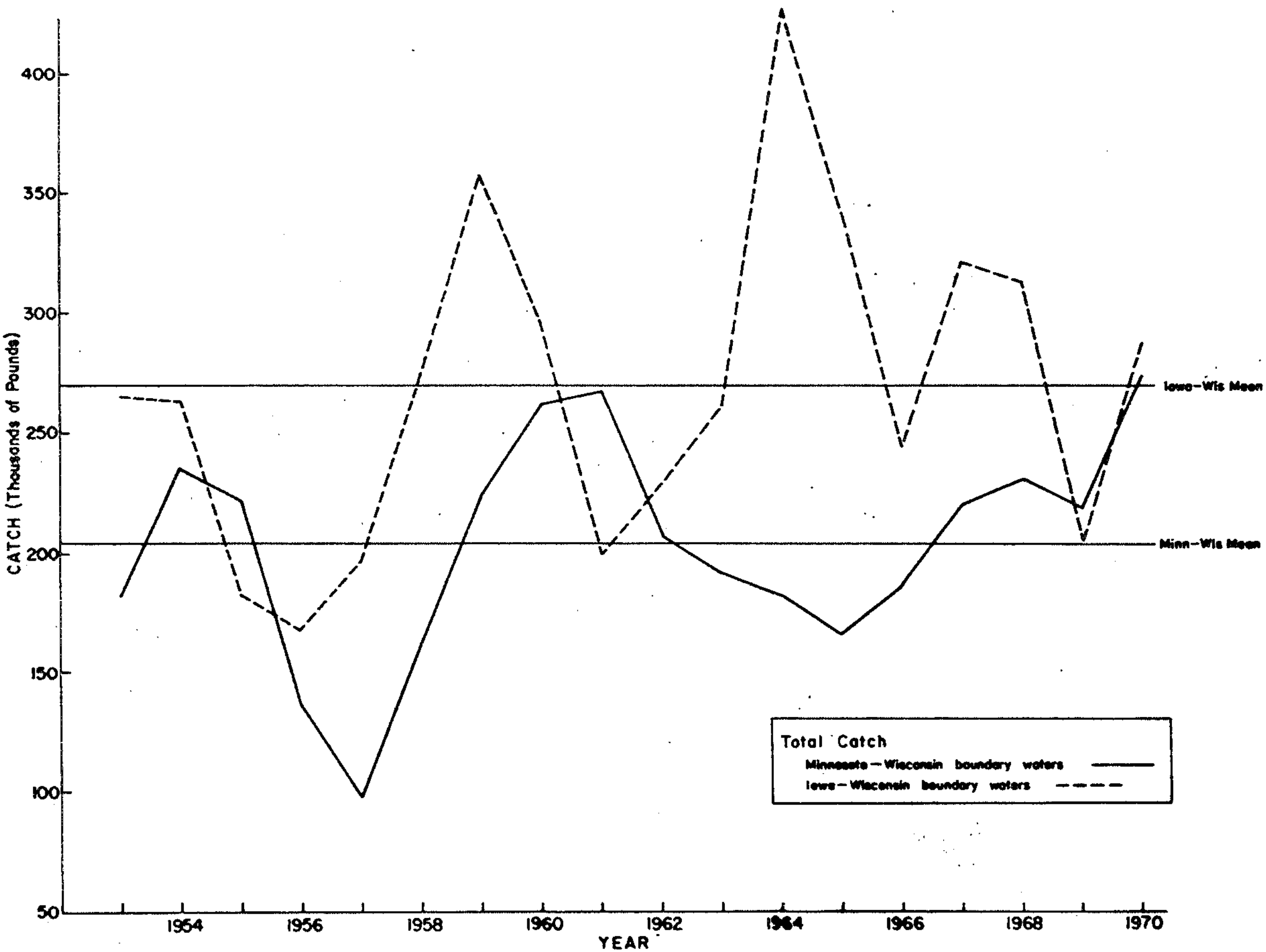

Figure 5 Total Catfish Catch in Minnesota-Wisconsin and in Iowa-Wisconsin Boundary Waters, All Major Gear Types Combined.

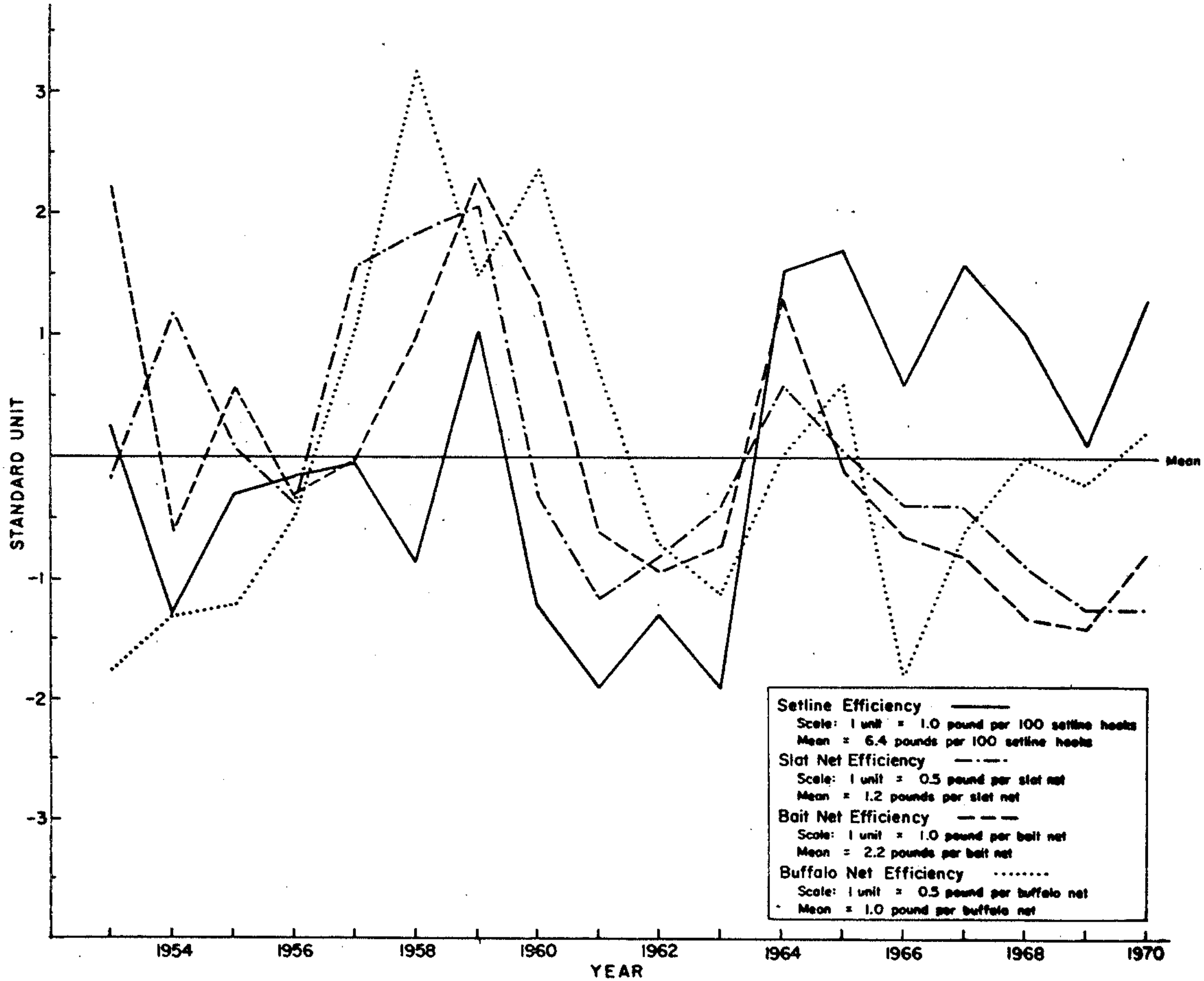

Figure 6 Efficiency of Major Gear Types for Catfish in Iowa-Wisconsin Boundary Waters.

In the next three years, efficiency was exceptionally high for all gears except setlines, which were variable. By 1960 setlines and slat nets had taken considerable declines to below-average levels, followed by bait nets in 1961 and buffalo nets in 1962. The efficiency of all gear remained below average in 1963, with a recovery to average and above levels in 1964-65. This rise was most pronounced and sustained for setlines, which stayed above average for the last five years, while the other gear types were mainly below average.

Comparing the catch statistics for each gear, slat net catch, effort (in actual units or setline equivalents based on 18-year mean ratios), and efficiency all followed a similar pattern of fluctuations, with three peaks followed by lows. Above and below average levels didn't always coincide for the three statistics, but in general, the peaks occurred in 1954, 1958-59, and 1964-65, and lows in 1956, 1961-62, and 1968-70. During the 18-year period, the highest effort occurred in 1954, the highest efficiency in 1959, and the highest catch in 1964. Record lows for all of the three statistics were recorded in 1969-70, resulting in a general trend of decline for catch, effort, and efficiency over the entire period. Slat net effort in setline equivalents derived from annual efficiency ratios did not follow trends comparable to the other statistics. It was below average prior to 1959, and above average 1959 through 1970. Lowest effort occurred in 1957 and highest in 1964-65 and 1967.

Setline catch and effort followed a similar pattern, generally above or near average through 1960 and below average 1962-70. Highest levels occurred in 1953-54 and 1959-60 and lowest 1965-66 and 1969. Efficiency trends were approximately the opposite, with most above-average levels 1964-70. All preceding years were below average with the exception of high catch and effort years of 1953 and 1959. Lowest efficiency occurred in 1961 and 1963 and highest in 1964-65 and 1967.

Bait net catch and effort (derived from both annual and 18-year mean efficiency ratios) also followed similar trends, primarily below average through 1961 and above average thereafter. Lowest levels occurred 1954-57 and highest 1970, resulting in a net upward trend for both statistics. Efficiency ran the reverse of the above, with most above-average levels before 1961 and all years thereafter below average except 1964.

Buffalo net catch and effort were below average through 1961 and above average 1962-70, with the exception of a below-average catch and annual efficiency ratio effort in 1966. The peak catch occurred in 1964, and peak effort in 1966 (18-year mean ratios) and 1963 (annual ratios). Both catch and effort showed an upward trend over the 18-year period. Most of the above-average efficiency occurred 1957-61, with the peak in 1958. Lowest efficiency years were 1953 and 1966.

Total effort based on 18-year mean efficiency ratios was low during the first seven years of the study and accompanied by rather variable catches, ranging from very low in the middle of this period to high at the end (Figure 7). Corresponding to this range of catches, efficiency levels ran from near average to a record high in 1959. Effort increased to levels ranging from average to moderately high from 1960 through 1965. Catch and efficiency were generally low early in this period and high at the end. High effort during the last five study years yielded variable catches, ranging from moderately low to moderately high, with efficiency below average. Catch and efficiency followed similar trends over the 18-year period. In general, effort and efficiency were inversely related at high and low levels, while intermediate effort levels were accompanied by a wide range of efficiency.

With total effort calculated from annual efficiency ratios, there was no consistent correlation between the annual levels of effort, catch, or efficiency (Figure 8). In general, high catch and efficiency rates were more prevalent in the last seven years of the study than previously, while highest effort occurred during the middle seven years, halfway between the high and low periods for catch and efficiency.

One of the more significant comparisons between Iowa-Wisconsin and Minnesota-Wisconsin sections involves the catch produced by equal amounts of fishing effort in each area. Minnesota-Wisconsin fishing averaged about one-fourth more productive than Iowa-Wisconsin, with 8.0 and 6.5 pounds per 100 setline hook equivalents, respectively. Minimum and maximum efficiencies compared similarly to the means. Low rates were 4.0 pounds per 100 hook equivalents (for effort determined from 18-year mean gear efficiency ratios) and 4.5 pounds (annual ratios) for Iowa-Wisconsin, and 5.3 pounds for Minnesota-Wisconsin. The corresponding maximum rates were 8.2 and 10.5 pounds (Iowa-Wisconsin) and 11.8 pounds (Minnesota-Wisconsin).

CATCH STATISTICS PER UNIT AREA

While the above efficiency rates indicate the level of return for effort expended, they do not express productivity in terms of an annual crop of protein food. The Minnesota-Wisconsin portion of the river includes about 1.7 times the surface area of water found in the Iowa-Wisconsin segment. If catch and effort statistics are considered on a per acre basis, Iowa-Wisconsin values are increased relative to Minnesota-Wisconsin. Effort per acre in Iowa-Wisconsin waters ranged from a low of 23 setline hook equivalents in 1955 to 91 in 1968, using 18-year mean efficiency ratios. For annual efficiency ratios, the range was narrower, 38 hook equivalents in 1956 and 81 in 1963. Both methods for determining effort had approximately the same mean, 60 hook equivalents per acre. This was 2 3/4 times as high as the mean level of 22 hook equivalents per acre in Minnesota-Wisconsin waters. The range here was 12 setline hooks per acre in 1957 to 32 in 1960.

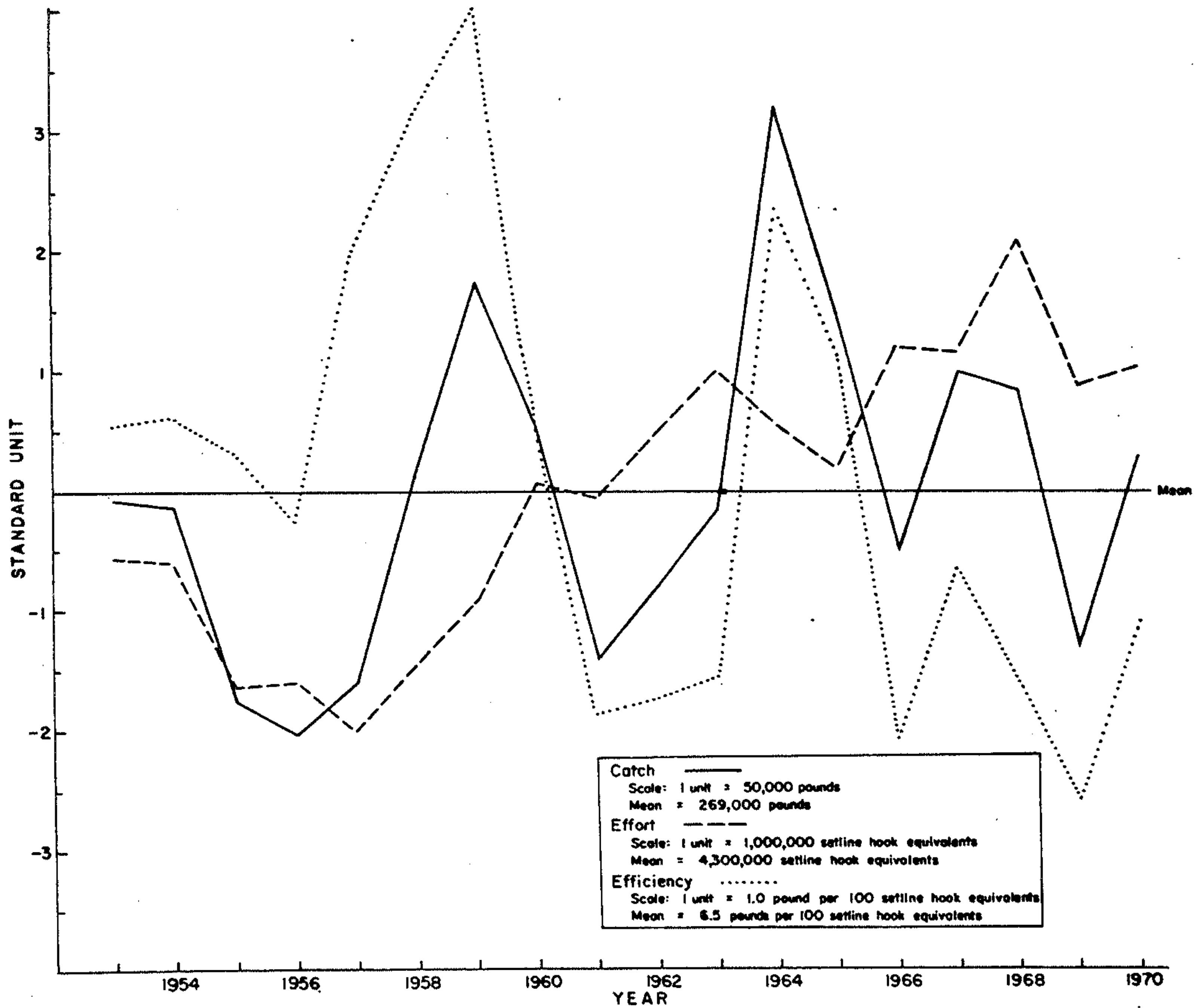

Figure 7 Catch, Effort and Efficiency of All Major Gear Types Combined for Catfish in Iowa-Wisconsin Boundary Waters (Based on 18-Year Mean Efficiency Ratios).

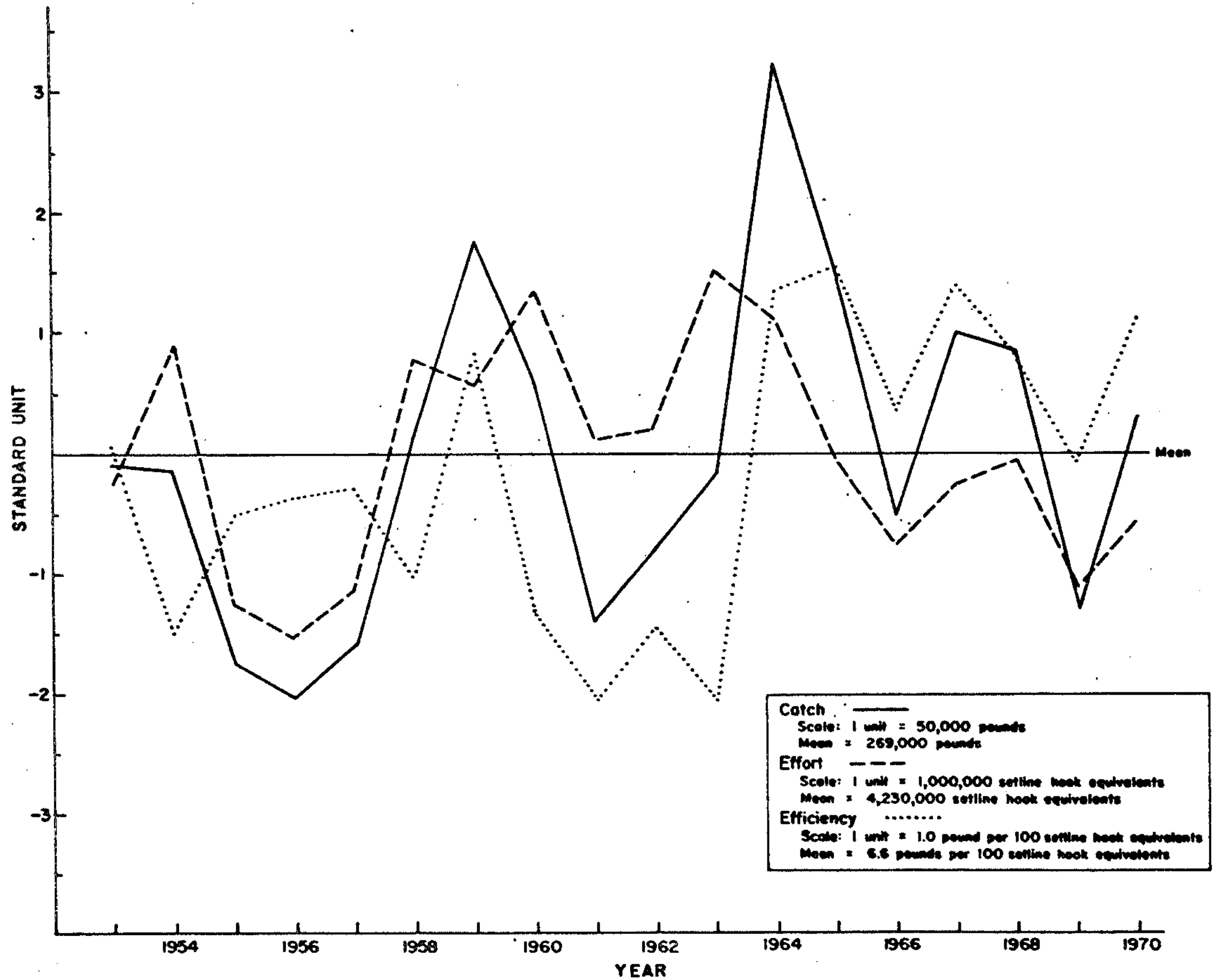

Figure 8 Catch, Effort and Efficiency of All Major Gear Types Combined for Catfish in Iowa-Wisconsin Boundary Waters (Based on Annual Efficiency Ratios).

Catch rates ranged from 2.4 to 6.1 pounds per acre in Iowa-Wisconsin waters, with a mean value of 3.8 pounds per acre about 2¼ times the Minnesota-Wisconsin mean of 1.7 pounds per acre. A range of 0.8 to 2.3 pounds per acre occurred in Minnesota-Wisconsin waters. The ratio nature of efficiency values eliminates influence from water surface area on their meaning.

It should be mentioned that surface area alone may not be an accurate indicator of the amount or quality of catfish habitat in the two areas discussed. Such factors as average water temperatures, fertility, and pollutants could have a significant influence on standing crop and growth rate in a particular unit of water area. In this respect, it is not known how the amount of potential "catfish water" may differ between the two areas.

FISHERY STABILITY

The extent of annual fluctuations in effort, catch, and efficiency were examined to evaluate the stability of the Minnesota-Wisconsin and Iowa-Wisconsin fisheries. Variation in setline effort between years in Minnesota-Wisconsin waters averaged 25 percent of the mean effort. Catch and efficiency were slightly more stable, 20 and 18 percent average annual fluctuations, respectively.

Variations in setline effort in Iowa-Wisconsin waters were about the same as for Minnesota-Wisconsin, 26 percent annual average. Slat net efforts varied 27 percent based on annual efficiency ratios and half that amount when 18-year mean efficiency ratios are used. Corresponding bait net fluctuations were 26 and 29 percent. Buffalo nets were more variable, 39 to 47 percent. Total effort fluctuations for all gear types combined was lower than that for Minnesota-Wisconsin, 12 to 19 percent.

Setline catches were the most stable of Iowa-Wisconsin gear types, 27 percent average annual fluctuation, followed by 31 percent for slat nets. Bait and buffalo net catches were more variable, 37 and 43 percent annually. The entire catch fluctuated 25 percent, less than any of the individual gears but somewhat more than Minnesota-Wisconsin.

Setline efficiency was slightly more stable than in Minnesota-Wisconsin water at 17 percent. The other three gears were considerably more variable: slat nets, 30 percent; bait nets, 43 percent; and buffalo nets, 50 percent.

ANALYSIS OF THE COMMERCIAL CATFISH CATCH FROM FISH MARKET SAMPLES

Samples were collected from important market outlets for the commercial catfish catch on three river pools in four years, 1963-65 and 1967 (Figures 9-10). The length and age of these catfish was examined annually and seasonally to determine the importance of different year classes and sizes of fish to the respective fisheries.

AGE DISTRIBUTION

Catch samples from Pool 9 generally contained more young fish than the Pools 4a and 7 samples, particularly during the last half of the season when over three-fourths of the catch came from the first year class available to the fishery, the three-year-olds (Figure 9). Less than 10 percent of the catfish in samples from Pool 9 were over five years old during the first half of the season, and over four years old during the second half. Six through nine-year-old catfish often made up 10 percent or more of the Pools 4a and 7 catches.

The Pool 9 catch could be expected to contain younger fish than those from Pools 4a and 7, even with similar age structures in the populations of all three pools. This is because the smaller size limit in Pool 9 allows the catfish to enter the fishery at an earlier age. However, the Pool 9 catch was more concentrated in the most significant age group which averaged about two-thirds of the total, compared to one-half for Pool 4a and three-eighths for Pool 7. Pool 7 contained 6 to 7 percent more fish than Pool 9 in each of the remaining year classes and Pool 4a, 2 to 6 percent more. In general, the age composition of the catch of all three pools showed a shift toward younger fish as the season progressed, probably reflecting the increased vulnerability of larger fish during the spawning run early in the season. This trend was more pronounced for Pool 9 than in Pools 7 and 4a.

SIZE DISTRIBUTION

Fish from Pool 9 market samples were generally smaller than those from the other two pools (Figure 10). Early in the season, fish from 13 to 15 inches were most significant in the catch, with fish as large as 17 inches sometimes appearing in considerable numbers. During the remainder of the season most of the catch was 13 to 14 inches, with considerable numbers as large as 16 inches occasionally occurring.

In early season samples from Pool 7, catfish from 15 to 19 inches were most significant, with those as small as 14 inches and as large as 22 inches sometimes taken in considerable numbers. As the season progressed, the fish tended to become somewhat more concentrated in the smaller size groups, 15 to 17 inches. With the exception of a July sample of small fish similar to those from Pool 9, catfish from Pool 4a were in about the same size range as those from Pool 7, with no seasonal variation or concentration of fish in a particular part of this size range evident. The smaller size limit in Pool 9 could produce size differences between the catfish from Pool 9 and those from Pools 4a and 7, independent of the actual size structure of the respective populations. Therefore, the size distributions relative to the size limit in each of the three respective pools were compared. Pool 9 had from 7 to 16 percent more fish in the size limit and one inch larger size groups than Pool 7 and 10 to 25 percent more than Pool 4a.

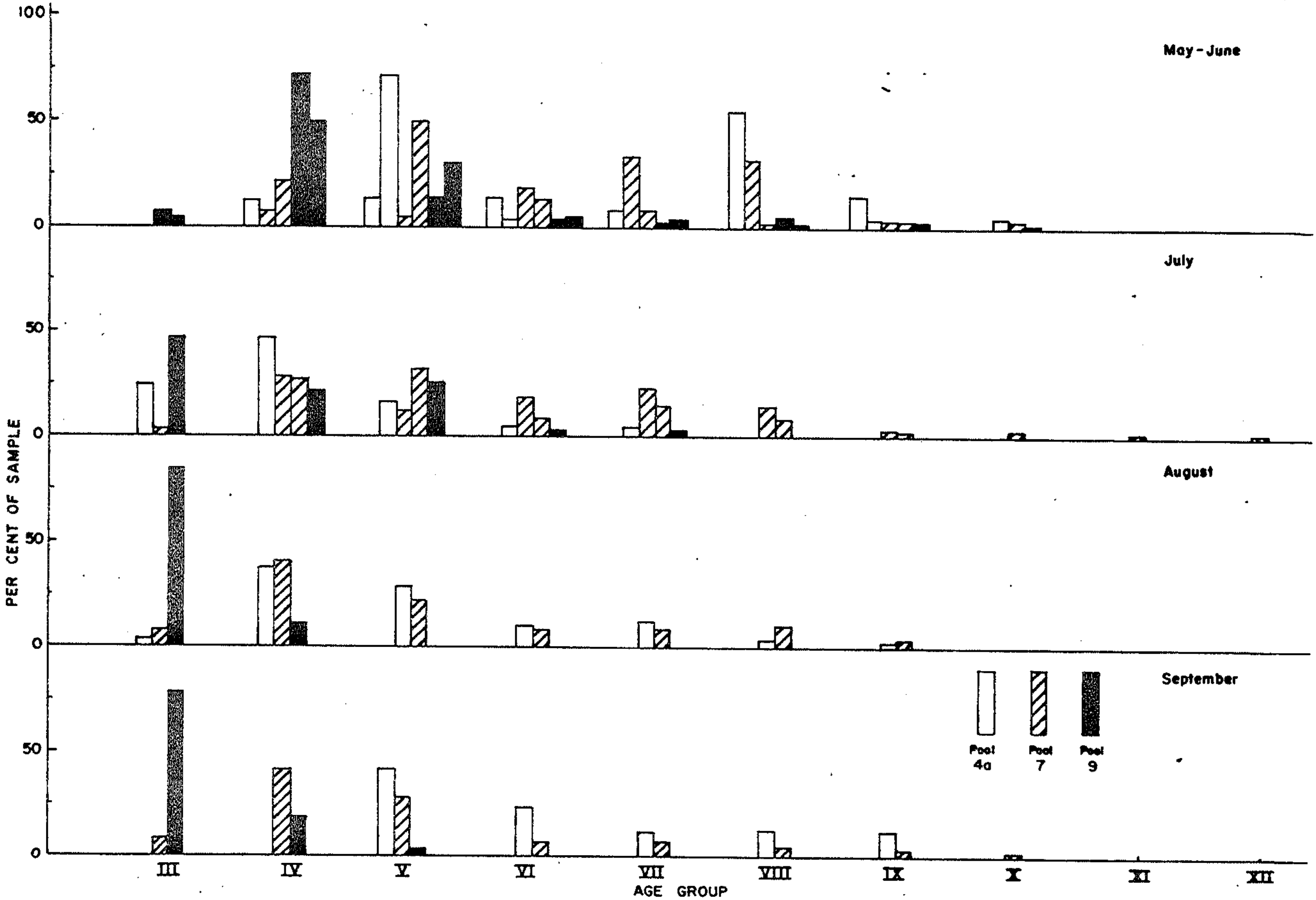

Figure 9 Age Distribution of Catfish in the Catch by Season and Pool.

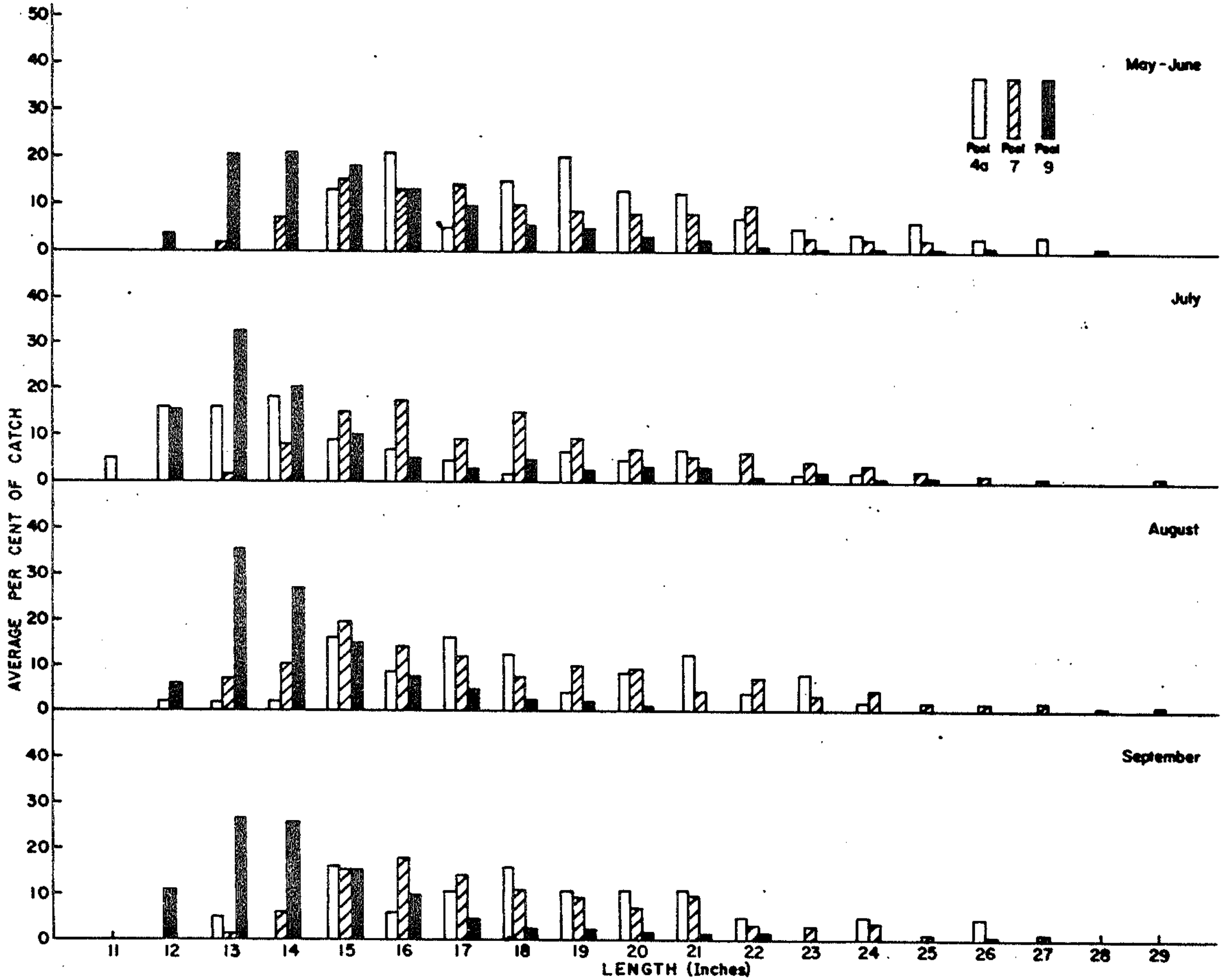

Figure 10 Average Percent of Catch of Catfish of Various Lengths by Season and Pool.

The size groups two and three inches larger than the size limit were transitional, in that Pool 7 has from 5 percent fewer to 4 percent more fish of this size than Pool 9. For Pool 4a the figures ranged from 10 percent fewer to 5 percent more. Pool 7 catfish four inches over the size limit and larger were 1 to 7 percent more numerous in the catch than in Pool 9. The percent of large fish in Pool 4a was also generally higher than for Pool 9, but the figures varied more widely, from 11 percent higher to 2 percent lower. In general, the differences in the size distributions between Pool 9 and Pools 7 and 4a were more pronounced after the first part of the season.

A considerable portion of some of the samples from all three pools were made up of fish one inch smaller than the size limit. Considerable numbers of catfish two inches under the size limit in Pool 7 and four inches under in Pool 4a occurred in some samples.

DISCUSSION AND CONCLUSIONS

Similarities in the statistical histories of the commercial catfish fisheries in Minnesota-Wisconsin and Iowa-Wisconsin waters were more prominent than the differences over the 18-year period examined. Cyclic fluctuations in catch, effort, and efficiency with one to four-year periods of increase and decline characterized both areas, without a strong indication of net trends. Iowa-Wisconsin fluctuations averaged somewhat greater than those in the Minnesota-Wisconsin area. The most prominent difference between the areas occurred in the last part of the study, when Iowa-Wisconsin had larger and more frequent variations in statistical parameters. Apparently, the more intensive multi-gear fishery in Iowa-Wisconsin waters did not influence catfish population levels sufficiently to noticeably alter catch patterns from those found in waters with a lower pressure single-gear fishery.

Gear efficiency can be used as a measure of the size of the fishable population, provided other factors affecting fish behavior do not influence catch rates enough to interfere significantly. Theoretically, gear efficiency will decline as the effort and catch increase in an expanding fishery to a point where further increase in effort brings declines in both efficiency and catch. Therefore, higher efficiency does not necessarily indicate a more productive fishery. Frequent effort fluctuations in the fisheries in this study did not allow a determination of the effort level corresponding to maximum sustainable harvest.

Setlining efficiency levels would indicate a high and increasing harvestable population was present in Minnesota-Wisconsin waters during the latter part of the study. A similar situation existed for Iowa-Wisconsin waters if overall efficiency is calculated using annual ratios to determine total effort, but the reverse is found if 18-year mean efficiency ratios are used. The source of this discrepancy is evident when the efficiency of the four Iowa-Wisconsin gears are examined individually. The high levels correspond to setline efficiencies, and the low rates to bait and slat nets, with buffalo nets intermediate. Therefore, gear efficiency does not appear to be a useful measure of population levels during the study period, probably due to significant influence from factors involving fish behavior.

A catch composed of a higher proportion of smaller, younger catfish in Iowa-Wisconsin waters than can be attributed to size limit differences alone may indicate the fishery there has harvested the population to a sufficient extent to affect its age and size structure.

The age and size composition of the catfish population could influence the potential of the fishery through its influence on the reproductive capacity of the breeding population. Determination of the relationship between the age and numbers of the spawning fish and the size of the year classes they produce would require considerably more information than afforded by the data collected in this study. However, some point exists where continued reduction of the number and size of adult fish will begin to lower recruitment. Additional investigation would be necessary to determine whether a lack of sufficient spawners could be lowering the harvest below its potential in Iowa-Wisconsin waters.

At some point in their life history, a year class of catfish puts on weight at a maximum rate in pounds per unit time, considering both growth and losses through mortality. The age and size of a considerable part of the catch in Minnesota-Wisconsin waters indicates that natural mortality of the smaller, younger fish which make up the bulk of the Iowa-Wisconsin catch may not be high enough to counteract their rapid growth as they approach maturity. Over one-third of the catfish growing from 13 to 15 inches would have to be lost to natural mortality before the increase in weight of the survivors would be completely counteracted. It appears likely that the Iowa-Wisconsin fishery may in effect be harvesting its catfish crop before it is mature in terms of optimum production. Variations in year class strength, whether fishery influenced or not, offer one plausible explanation for the strong short-term fluctuations in Iowa-Wisconsin fishery in recent years, considering the concentration of the catch in a narrow size and age range. Unfortunately, all fish market samples were collected in years when the catch was average or well above, so that a comparison of the abundance of particular year classes between high and low catch years was not possible. Variations in growth rates become increasingly significant as the size of the fish in the catch increases. As a result, relatively small fish in a particular size interval will originate from one or two year classes, while larger fish within the same interval of length will involve three or more year classes. Therefore, the effect of a small or missing year class would become less drastic as the size of the fish in the catch increases.

Opposition from commercial fishermen to regulation changes that would tend to increase the size of the catfish in the Iowa-Wisconsin catch is largely a result of special local markets that have been developed with restaurants for small catfish. These markets pay a considerably higher price per pound than can be obtained for the larger fish. An economic analysis evaluating the effect of anticipated increased catches sold at lower prices was made by Iowa biologist, Don Helms, and indicates a net economic gain would be realized from a two-inch size limit increase. Catfish raised in optimum numbers and size on fish farms may begin to significantly compete with wild river fish in the restaurant market in the near future. If this occurs, economic adjustments may result in a lessened resistance to an increased size limit.

Investigations of the catfish fishery in Iowa waters indicate that in general small fish become increasingly predominant in the catch progressing downstream. Also, the importance of catfish as a sport fish increases in the same manner. Therefore, benefits to sport and commercial fisheries from increasing the size of catfish in Iowa-Illinois waters can be expected to exceed those in Iowa-Wisconsin waters. In the interest of uniform regulations, it would be desirable to include the Iowa-Wisconsin section in such a size limit increase.

The data analyzed in this report clearly do not provide a thorough description of the range of possibilities in managing the catfish resource in Wisconsin boundary waters. A determination of the influence of natural and fishing mortality on catfish population size and age structure under different levels of exploitation would improve the ability to predict the probable influence of particular regulations on the catch. Population structure and environmental variables could be highly influential in determining annual reproductive success and susceptibility of the catfish to harvest, which in turn would affect catch and catch rate values.

If investigations into these areas indicate certain regulations do have potential for significant influence on the harvest, further studies would be needed to determine the type of catfish fishery that is most desirable. Regulations favoring the sport fishery might well be wasteful in terms of annual production of the maximum pounds per acre. The relative desirability of a moderate intensity fishery providing high catch rates for a large number of part-time fishermen or a high intensity one involving a few full-time operators and lower catch rates is another example of possible alternatives to be investigated.

SUMMARY

The statistical histories of a setline catfish fishery in Minnesota-Wisconsin waters and a more complex one involving both setlines and baited nets in Iowa-Wisconsin waters showed considerable similarity. Both had numerous short-term fluctuations without consistent trends of increase or decrease evident for the entire 18-year study period. Iowa-Wisconsin waters had a higher harvest rate than Minnesota-Wisconsin and a greater proportion of small catfish in the catch than could be entirely attributed to a lower size limit. This indicates that the Iowa-Wisconsin fishery may have been intensive enough to produce a noticeable decrease in the size and age structure of the population compared to that in Minnesota-Wisconsin waters. Information on catfish growth rates and longevity indicates the fishery might be more productive in both poundage and income if the harvest were delayed until the fish were allowed to reach a slightly larger size in Iowa-Wisconsin waters.

There was no indication that this fishery would not be able to maintain its current status under existing regulations, or that more restrictive regulations would insure a stable optimum harvest. The Iowa-Wisconsin river section investigated here is part of a larger section bordering all of Iowa, with the same fishery regulations. Iowa studies have indicated greater sport and commercial fishery benefits can be anticipated from tightened regulations south of Wisconsin than in the Iowa-Wisconsin section, so that the need for a regulation change for the entire area may be stronger than was indicated for the areas investigated in this study. A size limit increase or restriction of gear intended to increase the size of catfish in the harvest currently faces considerable opposition, largely due to established markets paying a higher price per pound for small catfish. To arrive at more definite conclusions about the impact of various regulations on catfish harvest than those available from the data analyzed here, additional investigations would be needed into mortality rates, factors determining year class strength, and environmental influences on fishing success.

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